Ministry of
Transportation and
Communications
Ontario

REPORT EM-47

INTERLABORATORY REFERENCE SAMPLE PROGRAMS FOR AGGREGATE, ASPHALT, CONCRETE AND SOIL TESTS

Engineering Materials Office

INTERLABORATORY REFERENCE SAMPLE PROGRAMS

FOR

AGGREGATE, ASPHALT, CONCRETE AND SOIL TESTS

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MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
ENGINEERING MATERIALS OFFICE

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INTERLABORATORY REFERENCE SAMPLE PROGRAMS

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INTRODUCTION

There are a large number of private sector and government laboratories in Ontario involved in the testing of aggregates, asphalt, concrete and soils. Test results produced by the laboratories govern acceptance/rejection of these materials. Inaccurate test results may cause unwarranted rejection or unjustifiable acceptance of a material. When either of these happen, the cost of construction and/or maintenance is adversely affected. Acceptance of substandard material may also affect the safety of the structure.

The values obtained from the testing of aggregates, asphalt, concrete and soils are subject to many variables such as test procedures, equipment, environment and competence of operators. Although the methods of carrying out the tests and test equipment are specified in detail, differences in results between laboratories do exist and, in some cases, they are substantial. These differences can be detected by an appropriate inter-laboratory correlation testing program. Laboratories aware of large departures from the mean test results can review their procedures and equipment, make appropriate changes and thus improve their own performance and the quality of the product sent to their clients.

There are no correlation test programs in Ontario designed to service directly the laboratories and indirectly the construction industry.

There is a need and there has been a demand for such a correlation program. The program described herein is designed for this purpose.

OBJECTIVES

The objectives of the correlation program are to:

i) provide each participating laboratory with a means of evaluating its relative performance in the testing of aggregates, asphalt, concrete and soils with a view to improving testing accuracy and precision

ii) increase confidence in the precision and accuracy of test results reported by the laboratories to their clients

To accomplish the above objectives it is proposed that at least one interlaboratory correlation test will be conducted for each test method each year.

The results obtained in this program may also be used for establishing precision criteria for some of the test methods covered by the programs.

PARTICIPATION

Participation in this program is to be voluntary. It is in the interest of testing laboratories to participate. All Ontario government and private laboratories are invited to join the program. A laboratory can apply for any or all of the programs shown in Table A.

Application to join any of the four programs should be made to:

Manager, Engineering Materials Office
Ministry of Transportation and Communications
Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

COORDINATING LABORATORY

The program will be conducted by the Engineering Materials Office of the Ontario Ministry of Transportation and Communications. Its laboratory, located at Downsview, will be the coordinating laboratory. It will prepare the reference samples and distribute them to participants, analyze test results statistically, prepare reports and distribute them, and arrange supplementary tests, if warranted.

FREQUENCY AND COST OF TESTS

It is believed that one round of tests per year will suffice for each of the four material groups. However, this frequency can be changed, if warranted, by experience gained from the correlation program and interest shown by the participants.

The cost of all the work to be done by the coordinating laboratory is shown in Table A. It is only an estimated cost. A better estimate will be obtained after the cost of the first two or three rounds of tests is determined. Each participating laboratory will be charged for each round of tests.

TEST METHODS

The methods of sampling and shipping samples to the participating laboratories, and the methods of tests to be followed by each laboratory, are described in Appendices A to H for each group of tests listed in Table A. Test report forms will be provided by the coordinating laboratory to each participant.

The appendices make reference to MTC test methods. These are described in MTC Laboratory Testing Manual. It can be obtained from:

Ministry of Transportation and Communications
Record Services Office
East Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8
(Tel: 416-248-3531)

REPORTING TEST RESULTS

Test results must be reported on the forms supplied with the samples and to the nearest decimal place shown on the forms. If anything unusual occurs during the test, it should be noted in the test report form under "Remarks". Comments about the test procedures are welcomed and should be made on the test report form or a separate sheet attached to the report.

The test report forms should be sent to the address shown on the forms immediately after completion of the tests. The deadline for the receipt of test results by the coordinating laboratory will be specified. Results received after that date will be excluded from the analysis.

ANALYSIS OF TEST RESULTS

The coordinating laboratory will review each report. If a report contains suspect test results and comments given by the testing laboratory justify rejection of the results, the results will not be used in the statistical evaluation.

Results of each test will be evaluated using statistical methods basically in accordance with 1) J.R. Crandall and R.L. Blaine, "Statistical Evaluation of Interlaboratory Cement Tests", Proceedings of ASTM, Vol. 59, 1959; 2) W.J. Youden, "Statistical Aspects of the Cement Testing Program", Proceedings of ASTM, Vol. 59, 1959; 3) "Use of CCRL Reference Sample Results for Precision Statements", ASTM Subcommittee C01.94 on Statistical Methods, Cement, Concrete, Aggregates, CCAGDP, Vol. 2, No. 1, Summer 1980; 4) ASTM E178-75, Standard Recommended Practice for Dealing With Outlying Observations.

REPORTS TO PARTICIPATING LABORATORIES

Each report for each test method will consist of the following:

i) Summary of test results - mean, standard deviation, coefficient of variation

ii) Scatter diagram - means from all laboratories for samples A and B

iii) Table of test results - individual test results, mean, range, departure from overall average and performance rating for each participant.

Each laboratory will be identified in each report by the same code number which will be known only to the coordinator and the participating laboratory.

The reports will be mailed to the participants as soon as they are available. Any questions regarding content should be addressed to the author of the report whose name, address and telephone number will be shown in the report.

INTERPRETATION OF LABORATORY RATINGS

Performance of each laboratory in each of the tests will be rated on a scale 0 to 5 and it will be based on the difference between the test result (mean) from the laboratory and the overall (all laboratories) mean, as follows:

≤1 standard deviation	- Rating 5
>1 to ≤1½ "	- Rating 4
>1½ to ≤2 "	- Rating 3
>2 to ≤2½ "	- Rating 2
>2½ to ≤3 "	- Rating 1
>3 "	- Rating 0

Each laboratory is expected to review the report in detail. If a laboratory receives a low rating (2 or lower), especially if the low rating is for two or more samples, it should review its test procedure and equipment to determine the cause. If warranted, arrangements can be made with the coordinating laboratory for a supplementary correlation test.

Test procedures and equipment should also be reviewed if a laboratory receives a "+" or "-" rating consistently. This means that the test results from the laboratory are consistently above (+ sign) or consistently below (- sign) the overall mean. The coordinating laboratory will maintain a record of the test results from each laboratory.

TABLE A TESTS, FREQUENCIES AND COSTS

Material	Tests *	Frequency of Tests Per Year	Estimated Average Cost Per Year Per Lab.
Aggregate	Fine		
	LS-602 Gradation LS-605 Absorption & Rel. Density LS-606 $MgSO_4$ LS-611 Attrition	1	100
	Coarse		
	LS-601 Wash Pass 75 µm LS-602 Gradation LS-603 LA Abrasion LS-604 Relative Density & Absorption LS-605 $MgSO_4$ Soundness LS-607 Percent Crushed Particles LS-608 Percent Flat and Elongated Particles LS-609 Petrographic Analysis	1	125
Asphalt	Mix Design		
	LS-261, 262 Bulk Relative Density of Compacted Mixture LS-261, 263 Resistance to Plastic Flow LS-261, 264 Theoretical Max. Relative Density LS-261, 265 Percent of Air Voids in Compacted Dense Mixture LS-261, 266 V.M.A. in Compacted Mixture 604, 605	1	150
	Mix Control		
	LS-282 Extraction of Bitumen From Mixture	1	50
	Cements		
	LS-200 Penetration LS-201 Flash Point (C.O.C.) LS-202 Kinematic Viscosity LS-205 Ductility	1	50
Concrete	LS-406, 407 Compressive Strength	1	100
	LS-400, 401 Concrete Mixes 402, 403 405, 506 407	1	100
Soil	LS-702 Particle Size Analysis LS-703 Liquid Limit LS-704 Plastic Limit and Plasticity Index LS-705 Relative Density LS-706 Proctor Density (Procedure 1)	1	75

* Not all tests or groups of tests will necessarily be conducted by each participating laboratory. It depends on response of individual laboratories.

METHOD OF PREPARATION AND TESTING OF FINE AGGREGATES FOR INTERLABORATORY CORRELATION PROGRAM

SCOPE

This method describes the procedures for the preparation, shipping and testing of fine aggregates for the multi-laboratory correlation program.

PREPARATION OF SAMPLES

Each round of the correlation program will involve four 10 kg samples for each laboratory. Sufficient bulk quantities of two similar fine aggregates shall be obtained from commercial sources. Each aggregate, in moist condition, shall be placed in a pile on a clean concrete floor and thoroughly mixed using a shovel. The pile shall then be flattened and separated into quarters. Samples shall be made up by filling each sample bag with approximately equal amounts of the aggregate from each of the quarters.

The number of bags of each fine aggregate shall be twice the number of participating laboratories and, in addition, several samples shall be made up for contingencies. The bags shall be assigned identification numbers.

ASSIGNMENT OF SAMPLES TO LABORATORIES

Each participating laboratory shall receive two bags of fine aggregate A and two bags of fine aggregate B. They shall be selected at random by the use of a table of random numbers or other suitable method. The samples made up for contingencies shall be stored by the coordinating laboratory.

SHIPPING

The two samples shall be shipped to the participating laboratories by truck or truck freight, as appropriate.

TESTING

All tests shall be conducted by technicians who normally prepare the routine samples and carry out the tests.

The material from each bag shall be tested for as many properties as the laboratory is equipped to test. The properties to be tested, after first preparing the samples, shall be as follows:

Gradation	- MTC Test Method	LS-602
Absorption and Relative Density	- "	LS-605
Magnesium Sulphate Soundness	- "	LS-606
Attrition	- "	LS-607

REPORTING OF TEST RESULTS

The test results shall be reported on the forms supplied with the samples. One copy shall be retained by the laboratory and the other one shall be mailed immediately after completion of the tests to the address shown on the form.

Send results to: Ministry of Transportation & Communications,
Engineering Materials Office,
Soils & Aggregates Section,
1201 Wilson Avenue,
Room 311, Central Building,
Downsview, Ontario. M3M 1J8.

Ministry of Transportation and Communications
Ontario

INTERLABORATORY CORRELATION PROGRAM

FINE AGGREGATE TEST RESULTS

LABORATORY Nº _____

TEST METHOD	SAMPLE Nº			
LS-602 SIEVE ANALYSIS Report percent on each sieve (not cumulative) to 0.1 %				
Material on 2.36 mm				
Material on 1.18 mm				
Material on 600 µm				
Material on 300 µm				
Material on 150 µm				
Material on 75 µm				
TOTAL MINUS 75 µm				
LS-605 BULK RELATIVE DENSITY (to 0.001)				
ABSORPTION (to 0.001 %)				
LS-606 MAGNESIUM SULPHATE SOUNDNESS Weighted average loss (to 0.01 %)				
LS-611 ATTRITION Loss on 75 µm (to 0.01 %)				

Remarks:

METHOD OF PREPARATION AND TESTING OF COARSE AGGREGATE FOR INTERLABORATORY CORRELATION PROGRAM

SCOPE

This method covers the procedures for the preparation, shipping and testing of coarse aggregate samples for the multilaboratory correlation program.

PREPARATION OF SAMPLES

Each round of the correlation program will involve four 30 kg samples for each laboratory. Sufficient bulk amounts of two similar coarse aggregates shall be obtained from commercial sources. Each coarse aggregate shall be oven dried and graded. Samples shall be made up by adding known masses of each size to each sample bag. Each bag shall contain the same amount of each size and the same total mass.

The number of bags of each coarse aggregate shall be twice the number of participating laboratories and, in addition, several samples shall be made up for contingencies. The bags shall be assigned identification numbers.

ASSIGNMENT OF SAMPLES TO LABORATORIES

Each participating laboratory shall receive two bags of coarse aggregate A and two bags of coarse aggregate B. They shall be selected at random by the use of a table of random numbers or other suitable method. The samples made up for contingencies shall be stored by the coordinating laboratory.

SHIPPING

The two samples shall be shipped to the participating laboratories by truck or truck freight, as appropriate.

TESTING

All tests shall be conducted by technicians who normally prepare the routine samples and carry out the tests.

The material from each bag shall be tested for as many properties as the laboratory is equipped to test. The properties to be tested and the test procedures shall be as follows:

Preparation	-	MTC Test Method	LS-600
Wash pass 75 µm	-	"	LS-601
Gradation	-	"	LS-602
Los Angeles Abrasion	-	"	LS-603
Absorption and Relative Density	-	"	LS-604
Magnesium Sulphate Soundness	-	"	LS-606
Percent Crushed Particles	-	"	LS-607
Percent Flat and Elongated Particles	-	"	LS-608
Petrographic Analysis	-	"	LS-609

REPORTING OF TEST RESULTS

The test results shall be reported on the forms supplied with the samples. One copy shall be retained by the laboratory and the other one shall be mailed immediately after completion of the tests to the address shown on the form.

Send results to: Ministry of Transportation & Communications,
Engineering Materials Office,
Soils & Aggregates Section,
1201 Wilson Avenue,
Room 311, Central Building,
Downsview, Ontario. M3M 1J8.

Ministry of Transportation and Communications
Ontario

INTERLABORATORY CORRELATION PROGRAM

COARSE AGGREGATE TEST RESULTS

LABORATORY Nº _____

TEST METHOD	SAMPLE Nº			
LS-601 WASH PASS 75 µm (to 0.01 %) _____				
LS-602 GRADATION Report percent on each sieve (not cumulative) to 0.1 %				
Material on 19.0 mm _____				
Material on 16.0 mm _____				
Material on 13.2 mm _____				
Material on 9.5 mm _____				
Material on 4.75 mm _____				
Material pass 4.75 mm _____				
LS-603 LOS ANGELES ABRASION (to 0.1 %) _____				
LS-604 BULK RELATIVE DENSITY (to 0.001) _____ ABSORPTION (to 0.001 %) _____				
LS-606 MAGNESIUM SULPHATE SOUNDNESS Weighted average loss (to 0.01 %) _____				
LS-607 PERCENT CRUSHED PARTICLES (to 0.1 %) _____				
LS-608 PERCENT FLAT & ELONGATED PARTICLES (to 0.1%) _____				
LS-609 PETROGRAPHIC ANALYSIS (enclose test forms)				
Petrographic Nº (to 0.1) Concrete _____				
Petrographic Nº (to 0.1) Granular _____				

Remarks:

METHOD OF PREPARATION AND TESTING OF BITUMINOUS MIXES FOR INTERLABORATORY CORRELATION PROGRAM

SCOPE

This method details the procedures for the preparation and shipping of ingredients and making and testing of bituminous mix specimens for the multilaboratory correlation program.

ASPHALT MIXES

Each round of the correlation tests shall involve two mixes of similar properties. The two mixes will be pretested by the coordinating laboratory to identify densities, stabilities, flows and V.M.A. The coordinating laboratory shall establish the mix proportions to be used by each participating laboratory.

PREPARATION OF INGREDIENTS

Coarse aggregates shall be obtained from commercial crushed rock or gravel stockpiles. P + 5 samples shall be taken for Mix A from stockpile A and P + 5 samples for Mix B from stockpile B, where P is the number of participating laboratories. Each sample shall contain approximately 25 kg of coarse aggregate. As the samples are bagged they shall be immediately numbered as follows:

CA01, CA02 ..... CA (P + 5) for Mix A
and CB01, CB02 ..... CB (P + 5) for Mix B

Fine aggregates shall be obtained from commercial stockpiles. P + 5 samples shall be taken for Mix A from stockpile A and P + 5 samples for Mix B from stockpile B. Each sample shall contain approximately 25 kg of fine aggregate. They shall be identified as follows:

FA01, FA02 ..... FA (P + 5)
and FB01, FB02 ..... FB (P + 5)

Asphalt Cement - One litre samples of A.C. shall be made up from 20 litre pails. They shall be poured and numbered in a manner described in the Method of Preparation and Testing of Asphalt Cements for Correlation Testing.

Assignment of Samples to Each Laboratory - Samples of each of the three ingredients for each mix for each participating laboratory shall be selected at random by the use of a table of random numbers or other suitable method. The additional five samples of each ingredient for each mix shall be stored to provide for replacements in case of loss or damage during shipping or for use in supplementary tests.

PACKING AND SHIPPING

Each set of samples shall be suitably packed to avoid damage during shipping. The samples shall be shipped to participating laboratories by truck or truck freight, as appropriate.

TESTING

Aggregates

On receipt of the bulk samples of coarse and fine aggregates, dry the samples to constant mass and grade the coarse aggregates. Test each coarse and fine aggregate for bulk relative density and absorption in accordance with MTC Test Method LS 604 and LS 605, respectively.

Mixes

Combine the dried aggregates as shown on the "Mix Design Weigh Card" supplied with the samples. MTC Test Method LS 261 shall then be followed to prepare the Marshall Specimens. Thereafter, the specimens which are made in two groups of three for each mix shall be tested for bulk relative density, maximum theoretical density, percent air voids and voids in mineral aggregate in accordance with MTC Test Method LS 262, LS 263, LS 264, LS 265 and LS 266, respectively.

REPORTING OF TEST RESULTS

The test results shall be reported on the forms supplied with the samples. One copy of each report form shall be retained by the laboratory and the others mailed immediately after completion of the tests to the address shown on the form.

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Ontario

INTERLABORATORY CORRELATION

MIX DESIGN WEIGH CARD

MIX A

% PASS 4·75 mm	% COARSE AND % FINE AGG.	COARSE AGG. GRAD. % CUMULATIVE ① / COARSE AGG. WT. g CUMULATIVE ②	COARSE AGGREGATE							FINE AGGREGATE Nº 1	FINE AGGREGATE Nº 2	% A C
			19·0 mm	16·0 mm	13·2 mm	9·5 mm	6·7 mm	4·75 mm	PASS 4·75 mm	BLEND _____	BLEND _____	
		①										
		②										

MIX B

% PASS 4·75 mm	% COARSE AND % FINE AGG.	COARSE AGG. GRAD. % CUMULATIVE ① / COARSE AGG. WT. g CUMULATIVE ②	COARSE AGGREGATE							FINE AGGREGATE Nº 1	FINE AGGREGATE Nº 2	% A C
			19·0 mm	16·0 mm	13·2 mm	9·5 mm	6·7 mm	4·75 mm	PASS 4·75 mm	BLEND _____	BLEND _____	
		①										
		②										

TEST REPORT FORM

INTERLABORATORY BITUMINOUS MIX STUDY

MIX NUMBER _____ A or B (circle one)

SAMPLE

COARSE AGGR. NO. _____
FINE AGGR. SAMPLE NO. _____
ASPHALT CEMENT SAMPLE NO. _____

SAMPLE / PROPERTY	1	2	3	4	5	6	REMARKS
Bulk Relative Density (nearest 0.001)							
Max. Relative Density (nearest 0.001)							
M.R.D. (S.D.) (nearest 0.001)							
Percent Voids (nearest 0.1)							
Percent Voids (S.D.) (nearest 0.1)							
Voids in Mineral Agg., % (nearest 0.1)							
Stability, N (nearest 1.0N)							
Flow, 0.25 mm Units (nearest 0.1)							
Coarse Aggregate - Bulk Relative Density (nearest 0.001)				Absorption, % (nearest 0.01)			
Fine Aggregate - Bulk Relative Density (nearest 0.001)				Absorption, % (nearest 0.01)			

MAIL RESULTS TO: MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
BITUMINOUS SECTION, ROOM 317, CENTRAL BUILDING
1201 WILSON AVENUE
DOWNSVIEW, ONTARIO M3M 1J8

TESTED BY _____

DATE COMPLETED _____

METHOD OF PREPARATION AND TESTING OF BITUMINOUS MIX CONTROL SAMPLES FOR INTERLABORATORY CORRELATION PROGRAM

SCOPE

This method details the procedures for the preparation, shipping and testing of mix control samples for the multilaboratory correlation program. Each round of the correlation program will involve two different mixes of similar properties. The mixes will be made up by the coordinating laboratory for distribution to the participating laboratories.

PREPARATION OF MIX SAMPLES

The two mixes will be set up to have similar (but not the same) gradings and asphalt contents. The coordinating laboratory will choose sufficient quantities of coarse and fine aggregates, mineral filler and asphalt cement to handle the needs for 2P + 10 samples of each mix. The mineral aggregates will have been dried and graded so that they may be batched into 1000 $\pm$ 10 g samples (including asphalt cement). The asphalt cement will come from one batch for each mix. Samples will be numbered in sequence as they are made up into lightly compacted briquettes and will be designated as follows:

MA01, MA02 ..... MA (2P + 10) for Mix A
and MB01, MB02 ..... MB (2P + 10) for Mix B

ASSIGNMENT OF SAMPLES TO EACH LABORATORY

Each participating laboratory shall receive two briquettes of each mix. They shall be selected at random by the use of a table of random numbers or other suitable method. The additional 10 briquettes of each mix shall be stored to provide for replacements in case of loss or damage during shipping or for use in supplementary tests.

SHIPPING

Each set of four briquettes (two Mix A, two Mix B) shall be suitably packed to avoid damage during shipping. The samples shall be shipped to the participating laboratories by truck or truck freight, as appropriate.

TESTING

The testing shall be carried out by two operators. One of the operators shall test one briquette of each mix and the other operator the other briquette of each mix.

On receipt of the samples, the four briquettes shall be tested in accordance with the MTC Test Method LS 282. The extracted aggregate shall be dried of all solvents as per the lab method and sieved. Percent of sample retained on the sieves shall be cumulatively weighed and reported on the report form supplied with the samples.

The percent retained on the sieves and the asphalt content of each sample shall be calculated and reported on the same forms.

Special Note: Use only one bowl and its matching lid for all four samples.

REPORTING OF TEST RESULTS

The test results shall be reported on the forms supplied with one copy retained by each of the participating laboratories.

TEST REPORT FORM

LABORATORY NO: _____ LABORATORY NAME: _____ ADDRESS: _____

MAIL REPORT TO: MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
Bituminous Section, Room 317, Central Building
1201 Wilson Avenue
Downsview, Ontario M3M 1J8

Test		MIX CONTROL A		MIX CONTROL B	
		SAMPLE MA ___	SAMPLE MA ___	SAMPLE MB ___	SAMPLE MB ___
MASS OF SAMPLE, g (nearest 0.1 g)					
MASS OF AGGREGATE, g (nearest 0.1 g)					
MASS OF ASPHALT CEMENT, g (nearest 0.1 g)					
A.C. % by mass (nearest 0.01 %)					
CUMULATIVE MASS RETAINED ON SIEVE, g (nearest 0.1 g) / % RETAINED, CUMULATIVE (nearest 0.1 g)	26.5 mm				
	22.4 mm				
	19.0 mm				
	16.0 mm				
	13.2 mm				
	9.5 mm				
	6.7 mm				
	4.75 mm				
	2.36 mm				
	1.18 mm				
	600 µm				
	300 µm				
	150 µm				
	75 µm				
OPERATOR		1	2	1	2

OPERATOR 1 TESTED BY _____ OPERATOR 2 TESTED BY _____

DATE COMPLETED _____ DATE COMPLETED _____

METHOD OF PREPARATION AND TESTING OF ASPHALT CEMENTS FOR INTERLABORATORY CORRELATION PROGRAM

SCOPE

This method details the procedures for the preparation, shipping and testing of asphalt samples for the multilaboratory correlation program.

ASPHALT MATERIALS

Each round of the correlation program will involve two asphalt cements of the same grade.

PREPARATION OF THE SAMPLES

Bulk samples of two asphalt cements of the same grade will be selected. These two asphalts may be from the same refinery but must be from different batches or lots.

Material A			Material B		
20 L Lot X	20 L Lot X	20 L Lot X	20 L Lot Y	20 L Lot Y	20 L Lot Y

Sufficient whole 20 litre pails of the same lots will be obtained to handle the following demand for supplies:

Two one-litre samples of Material A and Material B are required for each of P Laboratories. As well, there should be ten samples of Material A and Material B kept for storage in case of lost shipment or other problems. Thus 2P + 10 samples of both Material A and B must be made up. Each 20 litre pail has a 20 sample potential. If the number of samples required for laboratories and storage is greater than 20 or a multiple thereof the number of samples of each material should be the next higher multiple of 20.

If the 20 litre pails of asphalt are less than full a system of combining and ensuring a uniform product will be discussed with and approved by the Engineer prior to proceeding further.

The 20 litre pails of Materials A and B will be gently heated in an oven to approximately 120-130°C. When the material reaches the pouring temperature the pails shall be thoroughly stirred with a metal stirring rod for one minute. The one litre samples shall be poured and numbered in numerical sequence into previously marked triple seal cans.

Material A	A01	A02	A03	A20
	A21	A22	A23	A40
Material B	B01	B02	B03	B20
	B21	B22	B23	B40

ASSIGNMENT OF SAMPLES TO EACH LABORATORY

Each participating laboratory shall receive two one litre cans of cement A and two one litre cans of cement B. The cans shall be selected at random by the use of a table of random numbers or other suitable method. Ten one litre cans of each cement shall be assigned to storage for contingencies.

SHIPPING

Each set of two cans of cement A and two cans of cement B shall be suitably packed to avoid damage during shipping. The samples shall be shipped to the participating laboratories by truck or truck freight, as appropriate.

TESTING ASPHALT CEMENT

Each asphalt cement sample shall be tested within three weeks of receipt for the following properties according to the test method shown:

Test	MTC Test Method
Penetration	LS 200
Flash Point, C.O.C.	LS 201
Kinematic Viscosity	LS 202
Ductility	LS 205

The testing shall be carried out by two operators. One of the operators shall test one of the two samples (cans) of each cement and the other the other samples.

REPORTING OF TEST RESULTS

The test results shall be reported on the forms supplied with the cement samples. One copy shall be retained by the participating laboratory and the other one shall be mailed immediately after completion of the tests to the address shown on the form.

TEST REPORT FORM

Laboratory No: _____ Laboratory Name: _____ Address: _____

Mail results to: Ministry of Transportation and Communications
Bituminous Section
Room 317, Central Building
1201 Wilson Avenue
Downsview, Ontario M3M 1J8

Test	Material A		Material B	
	Sample #A ___	Sample #A ___	Sample #B ___	Sample #B ___
Penetration @ 25°C 100 g, 5 s, 0.1 mm (nearest 0.1 mm)				
Flash Point C.O.C., °C (nearest 1.0 °)				
Kinematic viscosity @ 135°C, mm^2/s (nearest 0.1 mm^2/s)				
Remarks				
Operator	1	2	1	2

OPERATOR 1

TESTED BY _____

DATE COMPLETED _____

OPERATOR 2

TESTED BY _____

DATE COMPLETED _____

Send results to: Ministry of Transportation & Communications,

METHOD OF MAKING, SHIPPING, CURING AND TESTING CONCRETE CYLINDERS FOR INTER-LABORATORY CORRELATION PROGRAM

SCOPE

This method covers the procedures for casting, marking, selecting, shipping, demoulding, curing, capping and testing of the standard concrete cylinders for compressive strength.

CONCRETE SPECIMEN, NUMBER OF SPECIMENS

Two classes of non air-entrained ready mix concrete shall be used in each round of the test. The slump shall be 80±10mm.

Four 150 mm x 300 mm cylinders shall be made from each class of concrete for each participating laboratory. Two of the cylinders shall be for 7d test and the other two for 28d test.

A maximum of 100 cylinders shall be cast from each load of concrete.

CASTING CYLINDERS

Each load of concrete shall be minimum 2 m^3. After initial discharge of approximately 0.5 m^3 (waste), the concrete shall be discharged into four 0.15 m^3 bins so that each bin is filled to its full capacity in one operation. Immediately after filling the bin, it shall be moved to the laboratory for casting cylinders in metal moulds (single use, CSA CAN3-A23.2-3C). The casting shall start as soon as possible. Each cylinder shall be made by filling the mould in two layers of approximately equal volume and compacting the concrete, after placing each layer, on a table vibrator for 3s. After consolidation, the top surface of each cylinder shall be finished with wood float with the minimum manipulation necessary to produce a flat even surface that is level with the top of the mould. Each cylinder from the same bin shall then be placed on an even, level base in the same group so that its consecutive number can be easily identified. As soon as casting of cylinders from each bin is completed, the group shall be covered with two layers of wet burlap. The casting and the initial curing shall be at 23±2°C.

MARKING AND SELECTING CYLINDERS

Each cylinder shall be legibly marked with a durable ink to identify the concrete sample (load of ready mix concrete) and the bin from which it was made, its consecutive number, laboratory to and test age for which it is destined.

4-1-A-3-7d 4-1-C-14-28d

4-1-B-16-7d 4-1-D-7-28d

test age
consecutive cylinder number
bin number
sample number
laboratory number

Cylinders for each laboratory shall be selected at random by first drawing a laboratory number from one box and then cylinder number from another box. The number of cards in the box shall be the same as the number of laboratories participating in the program and the number of cards in the other box shall be equal to the number of cylinders made from the same bin.

PREPARATION OF CYLINDERS FOR SHIPMENT

The cylinders in their moulds shall be cured under wet burlap at 23±2°C for at least 24h and not longer than 48h before placing each cylinder in two plastic bags. Each cylinder made from the same sample (load) of concrete shall be placed in the plastic bags at approximately the same time (+30 min), the identification number shall be marked on the bag and the bags shall be tied with a string. The cylinders to be shipped by air freight (express) shall be placed in groups of two in plywood crates lined with 12 mm thick polystyrene material to prevent damage to the cylinders during shipping. Each crate shall have sufficient number of 50 mm diameter holes in each side through the plywood and the styrofoam to ensure adequate ventilation (to prevent autogeneous, accelerated curing).

SHIPPING CYLINDERS

All cylinders shall be shipped by car, pick up truck or air freight (express), as appropriate, at the same time not earlier than 45h and later than 69h after casting. The arrangements shall be such that the cylinders arrive in the laboratories on the same day they are shipped with the exception of those shipped by air freight (express). The latter should arrive in the laboratories not later than the day after they leave the coordinating laboratory.

DEMOULDING AND CURING

Immediately after arrival in the laboratory each cylinder shall be demoulded and then marked to show its identification number, its condition on arrival shall be examined, its mass determined to the nearest 0.05 kg and then it shall be placed in a moisture room for curing in accordance with CSA Standard A23.2-M77-3C (Clause 5.3.2) (Storage in a lime saturated water is acceptable).

CAPPING AND TESTING

Capping and testing shall be in accordance with CSA Standard A23.2-M77-9C (MTC LS-406, LS-407). The caps shall be made of sulphur mortar; reuse of the mortar shall not be allowed.

Load shall be applied until the cylinders fail following which the form of break shall be observed and recorded on the form supplied with the cylinders.

REPORTING

The test results shall be entered on the forms supplied with the cylinders. One copy shall be retained by the laboratory and the other one shall be mailed immediately after completion of the tests to the address shown on the form. The form shall be fully completed.

CONDITION OF CYLINDERS ON ARRIVAL AND FORM OF BREAK

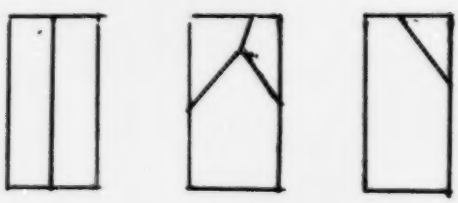
Condition of Cylinder on Arrival

1. Cylinder improperly made, testing not possible
2. Cylinder damaged, testing not possible

Form of Break

1. Satisfactory

2. Unsatisfactory



TEST REPORT

COMPRESSIVE STRENGTH - STANDARD CONCRETE CYLINDERS

Lab. No. _____ Lab. Name _____ Address _____

_____

Cylinder Identification Number	Date Made	Date Shipped to Lab.	Date Arrived in Lab.	Condition on Arrival	Mass, kg (nearest 0.05 kg)	Test at Age of d	Date Tested	Strength, MPa (nearest 0.1 MPa)		Form of Break	Method of Curing		Date of Last Calibra of Compres Machine
								Indiv.	Average		Moisture Room	Lime Sat. Water	
- -A- - 7d													
- -B- - 7d													
- -C- -28d													
- -D- -28d													
- -A- - 7d													
- -B- - 7d													
- -C- -28d													
- -D- -28d													

Remarks

Mail the report immediately after completion of 28d tests to: Ministry of Transportation and Communications
Engineering Materials Office
Concrete Section
Room 111, Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

METHOD OF MAKING AND TESTING CONCRETE MIXES FOR INTERLABORATORY CORRELATION PROGRAM

SCOPE

This method covers the procedures for the preparation and shipping of ingredients and making and testing concrete mixes for the interlaboratory correlation program.

CONCRETE MIXES

Each round of the correlation tests shall involve two classes of mixes. One of the classes shall be 20 MPa and the other 35 MPa. The concretes shall be non air-entrained. The mix proportions shall be specified by the coordinating laboratory.

PREPARATION OF INGREDIENTS

The fine aggregate sample for each mix for each participating laboratory shall consist of two bags of dry sand. The two bags shall contain the exact amount needed for the mix and the content shall be accurate to +0.05 kg. A load of sand in "as received" condition shall be divided into two approximately equal parts each containing approximately 60% of the amount needed for each mix for all participating laboratories. Each of the two parts shall be separately placed on a hard, clean, dust free floor and then mixed by depositing each shovelful on top of the preceding one in an adjacent location on the floor. The conical pile shall be flattened to a uniform thickness and diameter in such a manner that each quarter sector of the resulting pile will contain the material originally in it. The flattened mass shall be divided into four equal quarters. Approximately equal amounts of material shall be taken from each quadrant of the pile (at least three scoops from different locations of each quadrant) for each mix for each participant, placed on a metal pan and then dried in an oven to a constant mass. The oven dry material shall be weighed and placed in a plastic bag. The bag shall be tied with a string and marked Bag A, 20 MPa or 35 MPa, as appropriate. The plastic bag with its contents shall then be placed in a canvas bag which shall be securely tied with a string. Part B (Bag B) shall be prepared in the same manner. Each of the two bags shall contain approximately equal amounts of the material.

The coarse aggregate (sufficient amount for all participating laboratories) shall be sieved and then recombined separately for each laboratory to produce the following gradation:

Sieve size, mm	% passing
19.0	100
13.2	66
9.5	33
4.75	0

The total amount of the coarse aggregate for each mix for each laboratory shall be placed on a hard, clean, dust free floor and mixed to uniformity by turning over with a shovel. It shall then be placed in two plastic bags (approximately equal amounts). Each bag shall be tied with a string and marked 20 MPa or 35 MPa as appropriate. Each plastic bag with its contents shall be placed in a canvas bag which shall be securely tied with a string. The mass of the coarse aggregate for each laboratory shall be accurate to 0.05 kg.

Cement shall be weighed out in exact amounts (±0.025 kg) for each mix for each laboratory. A sufficient number of bags of cement of the same batch shall be obtained for each round of correlation tests. The amount weighed out for each laboratory shall be made out of approximately equal parts taken from each bag of cement. The cement for each mix for each laboratory shall be bagged and marked in the same manner as the aggregates except that it shall be placed in a double plastic bag (two bags).

The number of prepared samples of each ingredient shall be equal to the number of participants plus one for each 10 laboratories to provide for replacements in case of loss or damage during shipping. Samples of each ingredient shall be selected at random for each participating laboratory.

SHIPPING

The materials shall be shipped to the participating laboratories by pick up truck or truck freight, as appropriate.

DRY RODDED DENSITY

Each sample of the coarse aggregate shall be tested by each participating laboratory for dry rodded density in accordance with CSA Standard A23.2-10A. (MTC Test Method LS-400) Since the material was shipped in the exact amount necessary for a concrete mix, its entire original amount shall be recovered for making the mix.

MAKING MIXES

Each participating laboratory shall make the concrete mixes not later than two weeks after receiving the ingredients. Water for the saturation of the aggregates and the mixing water shall be local tap water. The entire sample of the fine aggregate, the coarse aggregate and the cement for the mix shall be used. No adjustments shall be made in the specified mix proportions. The fine and the coarse aggregates shall be saturated in accordance with CSA Standard A23.2-2C, Section 3.3.4(d) (MTC Test Method LS-401). The total water (absorbed and free water in the aggregates plus mixing water) used shall be exactly as specified in the mix proportion supplied with the materials.

Each laboratory shall receive a batch of materials for "buttering" the mixer for each mix in accordance with CSA Standard A23.2-2C, Section 4.3. It will not be necessary to saturate the aggregates.

The mixing procedure specified below (MTC Test Method LS-401) shall be used unless a different procedure is better adapted to the mixer being used:

i) Place 0.5 kg of water in the pan (drum).

ii) Place the coarse aggregate in the pan (drum).

iii) Place the fine aggregate and then the cement.

iv) Mix the contents of the pan (drum) for 1/2 min

v) Continue mixing without stopping for 1 1/2 min adding within this time all mixing water.

vi) Continue mixing for another two minutes.

vii) Stop the mixer, cover with moist burlap (if pan type), rest for three minutes and then remix for one minute.

viii) Stop the mixer and let the concrete rest for one minute before removing any concrete for testing. During this period cover the mixer as during previous rest period.

TESTING CONCRETE

Each fresh concrete mix shall be tested for the following properties:

Slump - CSA Standard A23.2-5C
(MTC Test Method LS-402)

Density - CSA Standard A23.2-6C
(MTC Test Method LS-405)

Air Content - CSA Standard A23.2-4C
(MTC Test Method LS-402)

The slump test is to be performed not sooner than three minutes nor later than five minutes after the final rest period (see MAKING MIXES viii). The air content test shall be performed concurrently with the slump test. (This can be achieved if filling of all the test containers is started one minute after the final rest period. During this extra one minute keep the concrete covered)

Six 150 mm x 300 mm cylinders shall be made from each mix. Three of these cylinders shall be for 7d and the other three for 28d test. In order to have sufficient concrete for these cylinders, the concrete used in the slump, density and air content (top 25 mm of concrete from the air meter container must be removed and discarded) tests shall be returned to the mixer and mixed for 8s to return the content to uniformity.

The cylinders shall be made, cured, demoulded, capped and tested in accordance with CSA Standard A23.2-3C, 9C (MTC Test Method LS-401, 406, 407). The caps shall be made of sulphur mortar. Load shall be applied until the cylinders fail following which the form of break shall be observed and recorded on the report form.

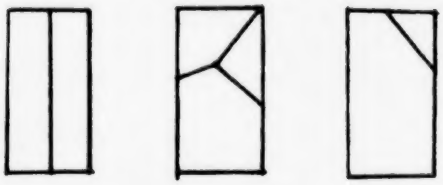
REPORTING

The test results shall be entered on the forms supplied with the samples. One copy shall be retained by the laboratory and the other one shall be mailed immediately after completion of the 28d strength tests to the address shown on the form. The form shall be fully completed.

FORM OF BREAK

1. Satisfactory

2. Unsatisfactory



CORRELATION TESTS, CONCRETE MIXES

Lab. No. _____ Lab. Name _____ Address _____

Test			Class of Concrete			
			20 MPa		35 MPa	
Density of Coarse Aggr., kg/m^3 (nearest 1 kg/m^3)						
Fresh Concrete	Slump, mm (nearest 5 mm)					
	Air Content, % (nearest 0.1 %)					
	Density, kg/m^3 (nearest 1 kg/m^3)					
	Yield, L (nearest 0.1 L)					
Compressive Strength, MPa (nearest 0.1 MPa)				Form of Break		Form of Break
	7d	Cyl. 1				
		Cyl. 2				
		Cyl. 3				
		Average		X		X
	28d	Cyl. 1				
		Cyl. 2				
		Cyl. 3				
		Average				
Type of Mixer		Pan		Drum Capacity L		
Remarks						

Mail the report immediately after completion of the 28d strength test to:

Ministry of Transportation and Communications
Engineering Materials Office, Concrete Section
Room 111, Central Building
1201 Wilson Avenue
Downsview, Ontario M3M 1J8

METHOD OF PREPARATION AND TESTING OF SOILS FOR INTERLABORATORY CORRELATION PROGRAM

SCOPE

This method describes the procedures for the preparation, shipping and testing of soil samples for interlaboratory correlation tests.

PREPARATION OF SAMPLES

Each round of this correlation program will involve four soil samples. Each of the first two samples will consist of two 30 kg bags and each of the other two samples of two 1 kg glass jars of the material it represents.

Sufficient bulk amounts of two similar soils shall be obtained from commercial sources. Each soil, in moist condition, shall be placed in a pile on a clean concrete floor and thoroughly mixed using a shovel. The pile shall then be flattened and separated into quarters. Samples shall be made up by filling each sample bag with approximately equal amounts of the soil from each of the quarters.

The number of bags of each soil shall be twice the number of participating laboratories and, in addition, several samples shall be made up for contingencies. The bags shall be assigned identification numbers.

The other two samples shall be similar materials. A sufficient amount of each material shall be oven-dried, pulverized and split to obtain the required number of samples. Two 1 kg glass jars shall constitute one sample. The jars shall be assigned identification numbers.

ASSIGNMENT OF SAMPLES TO LABORATORIES

Each participating laboratory shall receive two bags of soil A, two bags of soil B, two jars of Soil A and two jars of soil B. They shall be selected at random by the use of a table of random numbers or other suitable method. The samples made up for contingencies shall be stored by the coordinating laboratory.

SHIPPING

The samples shall be appropriately packed and shipped to the participating laboratories by truck or truck freight, as appropriate.

TESTING

All testing shall be conducted by technicians who normally prepare the routine samples and carry out the tests.

The material from each jar shall be tested for as many properties as the laboratory is equipped to test. The properties to be tested and the test procedures shall be as follows:

Preparation of Samples	- MTC Test Method	LS-700
Particle Size Analysis	- "	LS-702
Liquid Limit	- "	LS-703
Plastic Limit and Plasticity Index	- "	LS-704
Relative Density	- "	LS-705

The material from each bag shall be prepared in accordance with MTC Test Method LS-600 and tested for density in accordance with MTC Test Method LS-706.

REPORTING OF TEST RESULTS

The test results shall be reported on the forms supplied with the samples. One copy shall be retained by the laboratory and the other one shall be mailed to the address shown on the form.

Engineering Materials Office,
Soils & Aggregates Section,
1201 Wilson Avenue,
Room 311, Central Building,
Downsview, Ontario. M3M 1J8.

Ministry of Transportation and Communications
Ontario

INTERLABORATORY CORRELATION PROGRAM

SOILS TEST RESULTS

LABORATORY Nº _____

TEST METHOD	SAMPLE Nº			
LS-702 PARTICLE SIZE ANALYSIS (to 0.1 %)				
Passing 2.00 mm _____				
Passing 425 µm _____				
Passing 75 µm _____				
Finer than 20 µm _____				
Finer than 5 µm _____				
Finer than 2 µm _____				
LS-703 LIQUID LIMIT (to 0.1 %) _____				
LS-704 PLASTIC LIMIT (to 0.1 %) _____				
PLASTICITY INDEX (to 0.1 %) _____				
LS-705 RELATIVE DENSITY (to 0.01) _____				
LS-706 MOISTURE-DENSITY RELATIONSHIP (PROCTOR)				
Maximum wet density (to 0.001 t/m³) _____				
Maximum dry density (to 0.001 t/m³) _____				
Optimum moisture (to 0.1 %) _____				

Remarks: